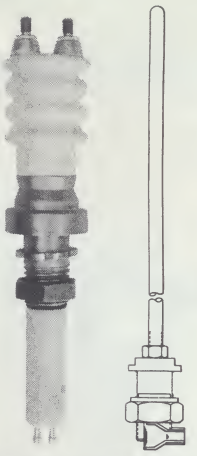
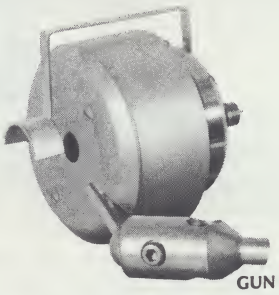
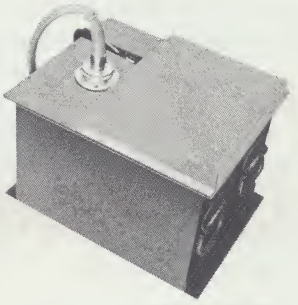


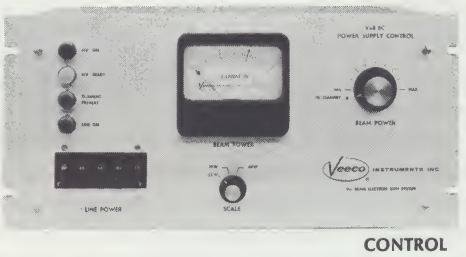
FEEDTHROUGH AND SUPPORT



GUN



TRANSFORMER



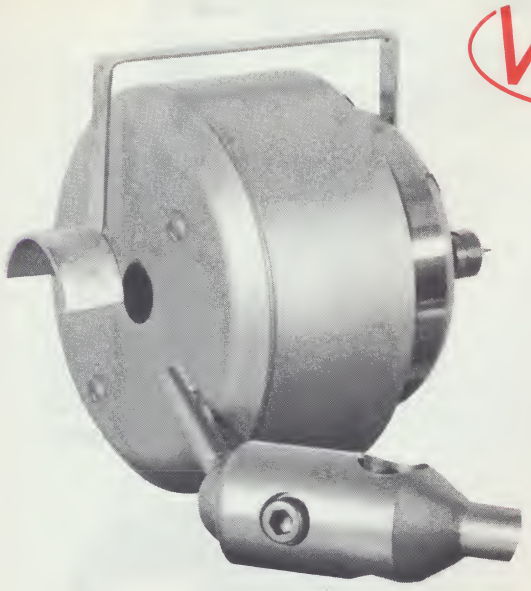
CONTROL

Veeco®

MODEL VeB-6

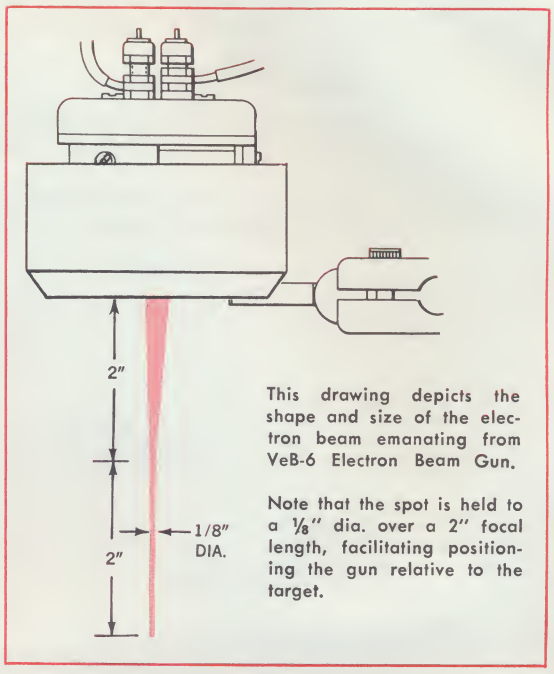
ELECTRON BEAM GUN SYSTEM

A Rugged, Reliable INTEGRATED ELECTRON BEAM GUN SYSTEM Designed Specifically for Modern Thin-Film Evaporation Requirements



VeB-6G Ve-Beam Electron Beam Gun showing Evaporation Shield and Deflection Plate.

Support and swivel members permit three-dimensional positioning of gun. Although shown here to right of gun they can be located on either side of gun for most advantageous positioning.



This drawing depicts the shape and size of the electron beam emanating from VeB-6 Electron Beam Gun.

Note that the spot is held to a ⅛" dia. over a 2" focal length, facilitating positioning the gun relative to the target.

Actual size of electron beam spot:

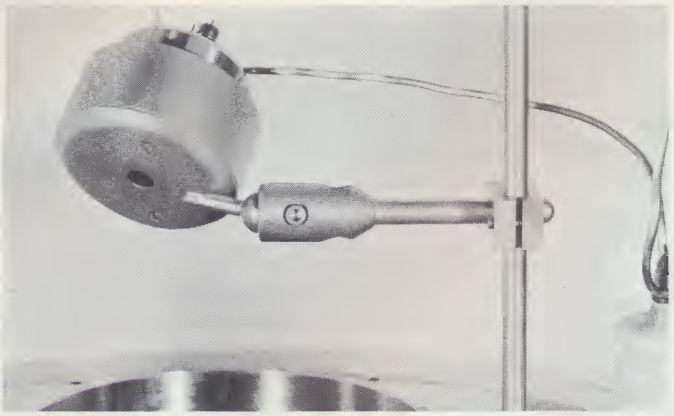
⅛" dia.

At 6KW maximum power, the power density is approximately half a million watts/sq. inch.

Ve-BEAM ELECTRON BEAM GUN SYSTEM

FEATURING . . .

- HIGHEST EFFICIENCY. Design of gun delivers at least 99.5% of the emission current to the source, assuring maximum power per dollar spent.
- UNIFORM DEPOSITION FROM SMALL SPOT. Electron beam spot is only ⅛" dia., giving high power density. The spot size is held along a 2" beam length, eliminating the need for critical positioning of gun.
- SMALL GUN SIZE. VeB-6G measures only 3" dia. x 3" long, can be placed anywhere in bell jar. Two-inch depth of focus allows gun to be positioned at optimum location relative to substrate, and eliminates need for high voltage regulation to keep spot size constant.
- MAXIMUM VERSATILITY. Power levels of 2KW, 3KW and 6KW are included to provide evaporation of essentially any known material at almost any desired rate.
- NO WATER COOLING REQUIREMENT. Modified Pierce design of VeB-6G eliminates the necessity of water-cooling; ambient cooling on gun is sufficient.
- NO MAGNETS OR MAGNETIC FIELDS. Electrostatic focusing and deflection obviate the need for bulky magnets, which can distort evaporation beam and contaminate substrate.
- ASSURANCE OF SUPERIOR DESIGN. The VeB-6 was designed specifically for vacuum evaporation; it is not a modification of zone refining, welding, or similar type guns. You are thus assured that the VeB-6 will perform any evaporation task required.
- REPEATABLE EVAPORATIONS. Beam power is read directly in watts for maximum repeatability. Only one knob is used to control evaporation, thus reducing operator error.
- HIGH PURITY THIN FILMS. Gun is designed for use in Ultra High Vacuum, so has maximum cleanliness, minimum virtual leakage. Low temperature of filament gives less than 10^{-9} parts back deposition of tungsten on substrate, but temperature is high enough (2300°C) to prevent deposition of source material on filament. Beam can be deflected, if desired, so that filament does not "see" evaporant.
- DEPOSITS OF PRECISE THICKNESSES. Since the VeB-6 power supply does not have to be regulated, it is ideally set up for application of the electron beam in "pulses", thus lifting off layers of source material down to a deposition rate of a few Å per pulse. Use of a thickness monitor allows very precise thicknesses to be deposited.



ELECTRON BEAM EVAPORATION

Electron beam guns are finding ever-increasing use for thin film evaporation. The use of electron beam heating for evaporation under high vacuum has numerous advantages over resistance and induction heating. Some are:

1. It is an ideal energy source for the evaporation of any type of material, since the concentrated energy from the electron beam can produce source temperatures many times greater than that obtained by resistance heating.
2. There is no contamination of the evaporant formed by reactions with the boat or crucible. In most cases the source acts as its own crucible.
3. Close control of the evaporant rates and thickness may be obtained. The source may be "lifted off" in layers, especially when using pulse techniques.
4. Heating can be uniformly distributed across the beam spot, giving more uniform evaporations.
5. Deposited films contain less residual gas inclusions due to higher rates of evaporation.
6. Alloys may be deposited maintaining essentially their bulk composition. High energy electron beam evaporation retains the composition of doped semiconductors. In resistance heating the active component of the dope is easily lost, thereby breaking up alloy composition.
7. Electron beam guns are one of the most economical means for obtaining very high concentrations of energy.
8. A number of films can be produced under varied conditions within a single cycle of the evaporator more easily, effectively, and with greater control. By using a rotary table for multiple evaporating sources, a material may be evaporated from the same point within the evaporator, thereby maintaining a constant geometrical solid angle of distribution over the substrate surface. This is not easily accomplished in resistance heating where materials are evaporated from different points in the system without recycling.
9. "Spitting" and subsequent film irregularities are minimized. In electron beam evaporation, the kinetic energy attained by the electrons as they leave the filament and are accelerated by the high voltage is converted to heat upon impact at the surface of the source. The heat generated raises the temperature of the source material causing it to evaporate or to sublime. This gaseous material leaves the surface in all directions and condenses as a solid film on the relatively cool substrate (in the same manner as normal evaporation by resistance heating).

HOW AN ELECTRON BEAM GUN WORKS

An electron gun is a device which generates, accelerates and focuses a beam of electrons. The elements of a gun may be divided into two categories: (1) the elements necessary for the generation of free electrons, and (2) the field shaping elements necessary for the production of a useful beam.

The basic essentials of any electron beam apparatus are, therefore, (1) a device for producing the electrons, (2) a method of accelerating these electrons towards the work piece, (3) control of the direction and focusing of the beam and (4) a vacuum environment of 10^{-4} torr or less in which the electron producing device is placed so that proper control can be exercised over the electron beam.

It is seen that a cathode for producing electrons, a method of accelerating them, and a bell jar pressure of less than 10^{-4} torr are relatively easily-achieved parameters. The major design effort, therefore, is directed toward generation of the electrode configuration, and hence beam shaping.

A brief description of the basic essential elements:

(a) Cathode: The cathode is the source of electrons and is an integral part of the electron beam apparatus. Electrons are generally emitted from the surface of a solid by applying a potential difference between a heated cathode surface and an external positive electrode.

The ability of a cathode material to emit electrons depends on its work function, which is the value of energy required to overcome the potential barrier at the surface of the metal. Due to its low work function tungsten is the material most generally used as a heated cathode (filament).

(b) Accelerating Potential: The potential necessary to accelerate the electrons is placed across the anode and cathode electrodes. This voltage is usually several thousand volts negative and is placed on the cathode, while the anode is held at ground potential. In a magnetic focusing gun this high voltage must be extremely well regulated or the spot will tend to "wander". In a Pierce-type gun (such as the VeB-6) this regulation is unnecessary.

A gun in which the anode is placed between the cathode and the evaporant material is called a "self-accelerated" gun. In some gun designs, however, the evaporant material itself is used as the anode; such guns are defined as "work-accelerated" guns. A work-accelerated gun is simple to construct, but suffers from an inherently large spot and from an inability to evaporate dielectrics directly by electron bombardment.

(c) Electrode Configuration: Determining the shape of field elements involves consideration of charged particle motion. When electrode shapes, potentials, and magnetic field configurations are known, it is possible to integrate the known equations of motion and thus determine the paths of the particles. In the design problem the desired electron trajectories are determined, and the fields necessary to bring about these desired paths and the electrodes and potentials necessary to establish those fields are developed.

(d) Vacuum: A vacuum environment is required in electron beam evaporation for the same reasons that it is required in resistance heating. In addition the vacuum must be sufficiently high to prevent ionic discharge between the filament and the evaporant. Usually 10^{-4} torr or better is sufficient. When the source material is evaporated it releases large amounts of gas, raising the pressure in the bell jar. The vacuum system should be of sufficient speed to hold this pressure rise to a minimum. For those cases in which high film purities are necessary, a vacuum system capable of attaining operating pressures in the 10^{-7}, 10^{-8} torr range is imperative.

DESIGN OF VEECO VeB-6

The VeB-6 utilizes a modified Pierce type configuration for its design. By use of the electrostatic focusing and self-acceleration inherent in this type of gun, magnetic fields are completely eliminated.

The Pierce gun is designed to operate with a space-charge limited cathode and to produce a uniform current density over the beam cross-section. The minimum spot diameter occurs beyond the anode, and thereafter the beam will diverge. One of the main advantages of the Pierce gun is its high efficiency, which may range to 99.5% or more,

Efficiency is defined as

$$\% \text{ eff} = \frac{\text{Actual beam current}}{\text{cathode emission current}} \times 100$$

which means that less than 0.5% of the cathode current may be lost to the gun electrodes due to scattering.

Pierce suggested that a uniform space-charge flow could be obtained over a limited region under the following circumstances: 1) if the region is considered to be a segment of extensive flow, and 2) if the cathodes and other electrodes are shaped to maintain along the edge of the segment the same voltage which would exist in the extensive flow. The only known exact solutions of the space-charge equations for electrons leaving a space-charge-limited cathode are those for rectilinear motion between parallel planes and between concentric cylinders and spheres. The solution between spheres is made use of in designing the Pierce gun.

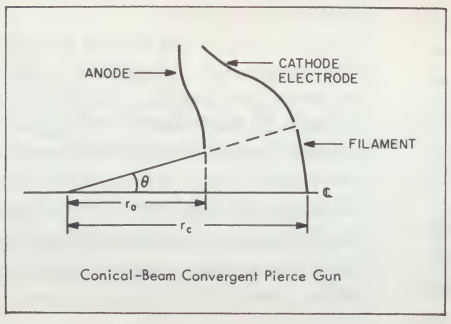
Parallel or cylindrical beam structures are of little use because the beam diverges immediately on leaving the anode aperature due to like-charge repulsion. In the case of convergent radial flow in a conical beam, if the semi-angle of the cone is large enough, the divergent action of the beam will be overcome and the beam will still converge. This beam may be looked upon as a segment of the radial flow between concentric spheres.

The solution for the current that flows in such a configuration in a cone of semiangle θ is given by

$$I = \frac{26.34 \sin^2 \frac{\theta}{2}}{\alpha^2} V^{3/2} \times 10^{-6} \text{ amp}$$

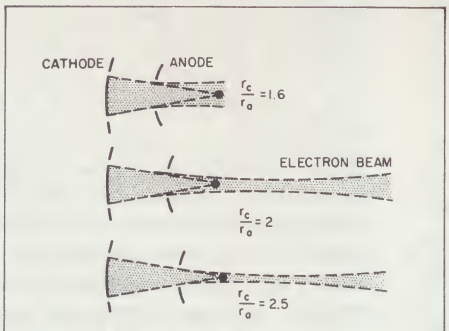
where V is the beam voltage in volts and α is a function of anode and cathode radii and is the design constant of the gun. (The values of α for corresponding r_c/r_a ratios are tabulated by Pierce).

For the design of the Veeco VeB-6 gun, $r_c/r_a = 2$, and $\alpha^2 = .750$. These values were found to satisfy the design parameters and to give optimum results.



Conical-Beam Convergent Pierce Gun

The anode and cathode of the VeB-6 are machined from stainless steel, and are positioned relative to each other by three high-density ceramic spacers. Filament lead posts are fabricated from OFHC copper. Because the anode and cathode are completely radially symmetrical there is no critical positioning except in an axial direction (*i.e.*, the distance from anode to cathode). This distance is held to within 0.002" by the high-tolerance ceramic spacers.



This figure depicts the Emerging Electron Stream for Various Ratios of r_c/r_a.

SPECIFICALLY DESIGNED FOR VACUUM EVAPORATION

The Veeco VeB-6 was developed by personnel directly experienced in the production of thin-films for microcircuitry. An "ideal" set of gun and system parameters and characteristics was set up as development objectives. Every one of these objectives is realized in the present VeB-6 system. The use of the VeB-6 will materially advance your present thin-film capability.

The following article, reprinted from the June 1966 issue of Industrial Research, graphically describes why and how the VeB-6 was designed and built.

More power, less voltage

An engineer working with thin films found certain drawbacks in existing electron beam guns and decided to design one that offered higher currents and increased power at voltages lower than normally required for a similar system.

Most other electron beam guns available at the time, he felt, were quite big — especially where a large amount of power was required. Other electromagnetically focused models had large coils that had to be placed inside the vacuum — resulting in a source of possible contamination and larger surface areas which had to be outgassed inside the vacuum.

With these points in mind, George McDonough initiated a research program at Veeco Instruments Inc. to study the problem. The project resulted in the development of a 6 kilowatt electron beam gun which incorporated new features and many of the advantages of existing models.

Essentially, the instrument is a Pierce-type configuration gun with modifications — whereby higher currents and increased power are obtained at a lower voltage.

At 11 kilovolts, for example, the Veeco gun attains 2 kilowatts of power—as compared to existing guns which achieved only 100 watts at the same voltage.

Another modification is that the gun is space charge limited, where all the electrons possible are pulled out of the cathode tube—resulting in more current for less input power.

The ½-pound gun is a compact unit, 2¼ inches in diameter by 3 inches in length, and can fit anywhere in a bell jar. Only one 1-inch feedthrough hole is required, and one knob controls the power density of a ⅛-inch spot without changing spot size, power uniformity, or depth of focus. Efficiency is 99½%. ■

Written by the staff of Industrial Research magazine, and reprinted with their permission.

Because the entire system was designed and built BY users FOR users, you are assured of purchasing an evaporation system which will continuously perform all required evaporation tasks.

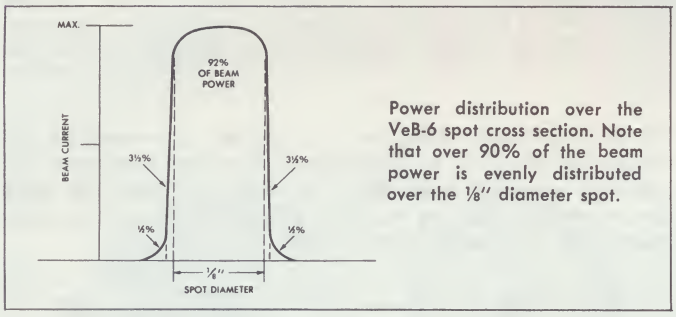
ADVANTAGES OF VeB-6

UNIFORM EVAPORATION

Uniform power density over the spot cross section results in uniformly deposited films on substrates, with more consistency among yields.

Power density is beam power per beam spot area ($D_p = P/A$). On the VeB-6 the well-defined spot diameter remains constant despite any electrical variations; therefore, it is easily seen that the power density remains constant at any power setting.

Uniform power density is of great importance when uniform evaporations are required. The material near the spot edge is evaporated at the same rate as that in the spot center, resulting in evenly deposited films and in greater, more consistent yields. Uniform power density is mandatory when evaporating alloys, to insure that all of the alloy material is heated to the same temperature across the spot and evaporated at the same rate. This points out one of the major benefits of the self-acceleration and electrostatic focusing of the VeB-6.

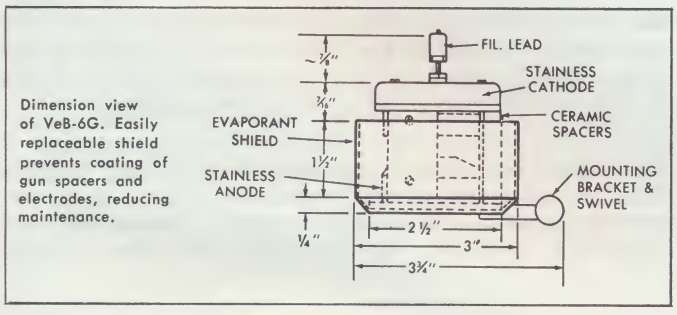


Power distribution over the VeB-6 spot cross section. Note that over 90% of the beam power is evenly distributed over the ⅛" diameter spot.

The VeB-6G Electron Beam Gun measures only 3" dia. by 3" high, easily fits into almost any high vacuum chamber. Long beam focal length provides for optimum placement relative to source.

Since the VeB-6G is small, there is very little difficulty in fitting it into any chamber, whether a conventional bell jar or a specially-built R&D chamber. This allows more flexibility in the placement of substrates and jigging, essential for increased production and for R&D studies.

Because of the self-acceleration and electrostatic focusing of the VeB-6, the beam spot is formed beyond the anode. This means that along the two-inch length from two to four inches from the anode end of the gun the spot diameter remains ⅛". (At six inches from the gun the spot diameter increases to only ⅜".) This long depth of focus eliminates the need for critical positioning of the gun, and coupled with the three-dimensional support rod and ball swivel allows for optimum placement of gun with respect to evaporant source. Addition of a deflection plate allows the gun to be positioned at a more acute angle so as to prevent the gun from "shadowing" the substrate.



EXACT FILM THICKNESS CAN BE DEPOSITED

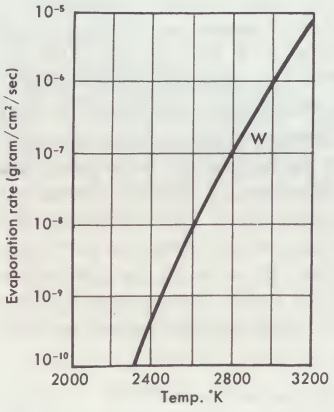
Use of pulsing techniques allows precise control of films by lifting off "layers" of source material, reduces heat to evaporant source.

"Pulsing" is an evaporation technique whereby the high-voltage accelerating potential is applied to the gun in extremely short bursts (pulses), filament current being held constant. By means of this technique, the evaporant may be lifted in very thin layers, allowing precise control of deposition thickness. Since the amount of evaporant deposited is dependent on beam energy, a low energy beam of less than a second duration can deposit films only a few Å thick. For highest quality thin film or circuitry deposition, and for R & D studies involving thin films, pulsing is an extremely advantageous technique.

Another benefit of pulsing is a great reduction of heat to the evaporant source. Because the electron beam strikes the source in pulses of extremely short duration, very little heat remains in the source material after each pulsed evaporation. This means that few gasses will be liberated either from the source material itself or from surrounding material, thus ensuring high purity films. Pulse technique cannot be used with a regulated power supply because of the inherently large decay time of the voltage peak. The VeB-6 does not require a regulated power supply, due to the long focal length of constant diameter, and therefore lends itself readily to pulsing. Pulsing equipment is currently not supplied by Veeco; however, the VeB-6 can be adapted at the customer's plant, when required.

HIGH-PURITY EVAPORATIONS

Filament temperature is kept between 2200°-2500°C for long filament life, infinitesimal back-deposition.



Evaporation rate versus temperature for tungsten.

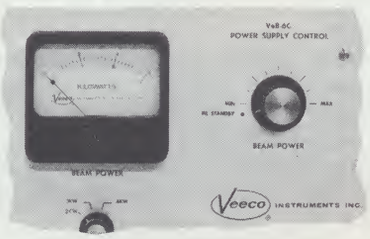
There is sometimes concern regarding possible back-deposition of source material onto the gun and filament. In almost all cases this concern is needless. At high filament temperatures the evaporated material will not adhere to the filament because the filament is too hot to condense the evaporant. The gun itself may become slightly coated with the evaporant material, but use of the shield, or occasional cleaning, will eliminate any problems which might result from material buildup on the gun.

A tungsten filament operating at 2200° to 2500°C evaporates itself at the rate of only 2×10^{-9} gms/cm²/sec. It is intuitively seen that due to the solid angle of distribution and the baffling effects of the gun electrodes, only an infinitesimally small quantity of tungsten will be deposited on the source. From the source the tungsten is re-evaporated through a solid angle of distribution, resulting in even smaller quantities finally depositing anywhere. In the final analysis this back-deposition impurity is entirely insignificant, and in the case of the VeB-6 it results in approximately only one part per billion. Materials this pure are not even commercially available. Its insignificance as well as that of filament sputtering is further supported by the very long filament life (500 hours or better) in the Veeco VeB-6. Should still higher purity of deposits be required, however, the beam may be deflected with the VeB-6D electrostatic deflector. The uncharged tungsten molecules will be separated from the deflected beam of electrons and will not strike the source.

REPEATABLE EVAPORATIONS

Beam power is read out directly in watts, is varied by only one knob. Beam power available for evaporation is independent of the source material; exactly-repeatable results are thus obtainable.

Regardless of the voltage level used, the beam power *at the evaporant* is read directly in watts, not current, on a *wattmeter*. This allows the operator to evaporate a material at the same power level every time. In addition, voltage to the VeB-6 gun is kept constant while filament emission current — and consequently beam power — is varied by a single knob. Thus, *repeatable* evaporations are easily accomplished, providing close control over the quality of processed parts.



MAXIMUM VERSATILITY

Choice of three maximum power levels each continuously variable from 0 to maximum, makes the VeB-6 the most versatile electron beam system presently on the market.

The VeB-6 is designed with three separate high voltage selections of 11 KV, 15 KV, and 20 KV. These correspond to power ratings of 2 KW, 3 KW, and 6 KW respectively, at maximum current settings. With these power settings it is possible to evaporate essentially all known materials at high rates of deposition. For example, at 6 KW iron may be deposited at rates of up to 3000 Å per second at a 4" source-to-substrate distance; other materials, such as Al, Au, Cu, may be deposited at much higher rates. Because of the high efficiency of the VeB-6, almost all materials can be evaporated at the 2 KW power level. However, if higher deposition rates are required (e.g., for increased production or for short exposure of film to released gasses), they are available by switching to higher power levels. Because of the X-radiation encountered at the 15 KV & 20 KV levels, however, a stainless bell jar or a radiation shield is recommended, when working at those levels.

For R & D operations the three power levels offer a great amount of versatility in the studies of thin films and the effects of deposition rates on film quality.

NO WATER COOLING REQUIRED

No water cooling means high gun efficiency, no water feedthrough problems.

The VeB-6 gun is physically separate from the crucible due to its Pierce-type construction; need for water-cooling is therefore eliminated. Although not required, water-cooling of substrate or crucible can of course be used, if desired.

Work-accelerated guns utilizing such water cooling typically lose up to 40% of their beam power in dissipated heat. For example, a gun rated at 3 KW may actually have *available for evaporation* an electron beam of only 1.8 KW. The Veeco VeB-6 gun, on the other hand, has an efficiency of 99.5%, which means that only 0.5% of the beam power is lost.

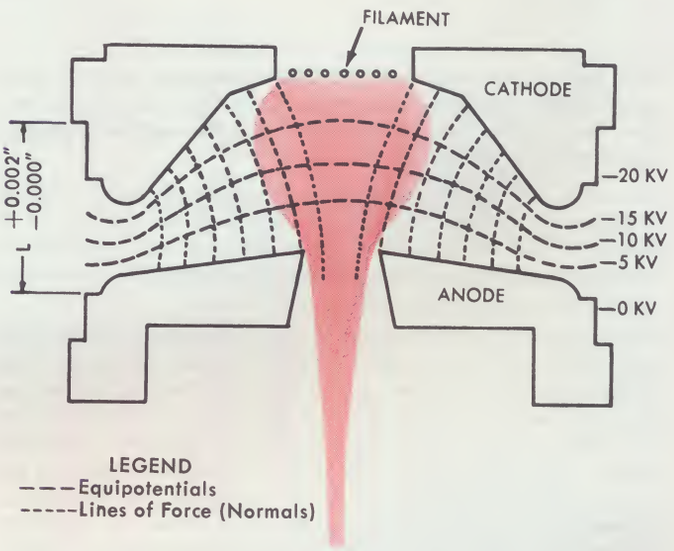
NO MAGNETS OF ANY TYPE REQUIRED

Electrostatic focusing results in complete elimination of all magnets, and gives a stable, well-defined beam spot. It also eliminates outgassing and large surface areas associated with cast permanent magnets and electromagnets.

One of the major problems which has plagued users of magnetically focused electron beam guns is the variation in size and location of the beam spot due to aging, heating, and evaporation of the magnets. When a magnet is heated it changes its flux density; therefore, during prolonged evaporation, radiant heat and stray or secondary electrons will heat the magnets, changing their flux densities and causing the beam spot to change its location and its size. This alters the power density across the spot, causing uneven film deposition because of irregular and uneven heating of the evaporant.

The presence of magnetic fields causes problems in itself. Electron paths may be altered, especially in fields close to the filament (such as those self-generated by induction in a coiled filament), causing irregular bombardment of the source. When evaporating magnetic materials (e.g., for magnetic computer heads), magnetic vapor patterns may be distorted.

All these problems have been completely eliminated by the design of the VeB-6. Electrostatic focusing eliminates the need for magnets; long depth of focus eliminates the need for secondary focusing magnets; bifilar filament design does away with induced magnetic fields.

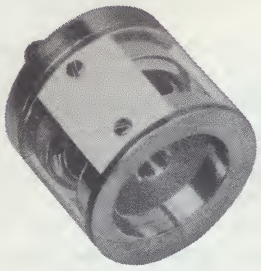


UHV CAPABILITIES

Use of only Ultra High Vacuum materials in construction, bakeability to 400°C, and relief on all threads makes VeB-6 ideally suited for R & D evaporation studies. It also results in much cleaner production evaporation.

The VeB-6 is designed for operation from 10^{-4} torr to below 10^{-10} torr. Materials of construction are stainless steel, low-porosity ceramic, and beryllium copper. Besides their low outgassing properties, these materials also allow for bak-

ing at temperatures up to 400°C for maximum cleanliness. In addition, an important detail often overlooked by other manufacturers is given its proper importance in the design of the VeB-6; virtual leakage is essentially eliminated by the exclusion of internally-placed clamps, and by techniques such as slotting threads and relieving blind holes and bolts. This results in less overall outgassing of the gun, and therefore in cleaner evaporations even at standard operating pressures.

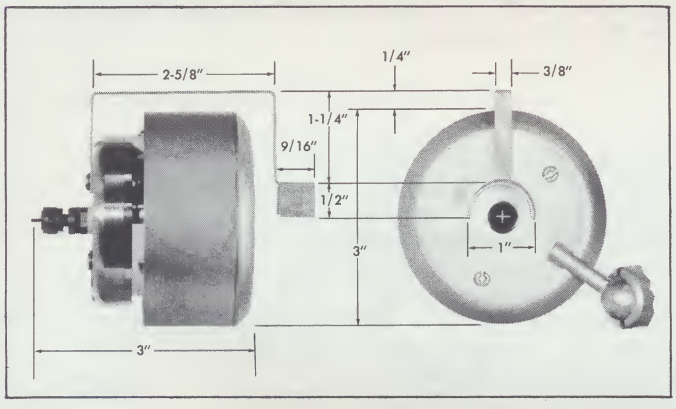


VeB-6G Electron Beam Gun, shown without shield or deflector.

Note absence of large bolts, washers, and other hardware which produce virtual leaks.

EASY BEAM DEFLECTION

VeB-6D Deflection Plate deflects beam electrostatically, eliminating need for bulky outgassing magnets.



Deflection of the electron beam in the VeB-6 system is performed by means of an electrostatic deflection plate. This eliminates the need for a deflection "yoke" or other device using magnetic fields. All magnets have relatively large surface areas which outgas and prevent the rapid attainment of operating pressures. Electro-magnets in particular are great potential sources of virtual leakage due to their windings. Use of an electrostatic deflection plate completely eliminates these problems.

The deflection plate is attached to the cathode end of the gun by two screws, and therefore operates at the cathode potential. Proper deflection and circular spot shape are assured by the geometrical design of the plate. The angle of deflection is approximately 40°.

PROTECTION FEATURES

The VeB-6 is fully protected against misuse; is easily and safely operated by non-skilled personnel.

Both the VeB-6 Control and VeB-6T Transformer are designed to eliminate the possibility of damage due to improper usage. For example, the VeB-6C will only operate in the prescribed logical sequence. That is, the filament must preheat for ten seconds before high voltage may be applied, and it will not turn on unless the filament current Variac is set at zero.

The entire system is protected by a primary circuit breaker which opens in case 1) input current exceeds breaker rating, 2) anode shorts to cathode (due, for example, to ionic discharge, or deposition over entire ceramic spacer), or 3) the high voltage terminal shorts to ground. In addition, power to the gun is interrupted, requiring operator to reset and recycle system if the total beam current exceeds the allowable maximum, or if electron or ion current is excessive.

An interlock is provided for attachment to the customer's ion gauge control or other vacuum switch to de-energize the filament before the bell jar is vented. Another interlock is also provided for operation with a rate and/or thickness monitor. To prevent evaporant from depositing on the ceramic spacers and causing a subsequent anode-to-cathode short circuit, Veeco has incorporated into the VeB-6 a unique anode shield. This shield also prevents back-deposition onto the anode and spacers, thus greatly reducing maintenance.

In addition, Veeco includes a Gun Positioner, which fits into the anode end of the gun and assists in aiming the gun so that the beam will strike exactly where desired. Once the gun is correctly positioned, the Gun Positioner may be easily removed without disturbing either the gun or the evaporant source.

The high-voltage transformer used with the VeB-6 is oil-filled to prevent internal arc-over and to promote cooling. Additionally, the transformer is designed to operate at at least 10,000 ft. elevation, so operation at practically any location is assured. Safety features on the transformer allow repeated short-circuits without harm, which demonstrates its ruggedness and excellent design.

Users are protected from capacitance in the high voltage circuit and cable by means of an internal bleed resistor. This resistor discharges the capacity 99% in only 5 seconds after power is removed from primaries.

FILAMENT DESIGNED FOR MAXIMUM EFFICIENCY

Flat, bifilar filament construction provides monoenergetic electron beam, eliminates induced magnetic fields.

Since a magnetic field is created by a current-carrying conductor, the filament on an electron beam gun creates its own field during operation. This field may prove to be a problem when the gun is used for deposition of magnetic materials, and may affect electron paths and focusing.

To avoid this problem a bifilar spiral filament is used as the heated cathode in the VeB-6. As current flows through the filament in the direction of the arrows (see photo), any two closely adjoining filament elements have currents flowing in opposite directions. In this manner magnetic fields created by these current loops oppose and cancel each other.

The *flat* bifilar construction also provides for the production of electrons from an equipotential plane, thus forming monoenergetic electrons necessary for proper electrostatic focusing.

GUN SPECIFICALLY DESIGNED FOR VACUUM EVAPORATION

Because the VeB-6 is specifically designed for thin film evaporation, all parameters affecting its operation for vacuum deposition were fully considered, resulting in a *complete, simple-to-operate* electron beam gun system.

With the VeB-6, one obtains a completely integrated electron beam gun system, ready to set up for evaporation. There are no "recommended accessories," such as necessary feedthroughs, to be purchased at extra cost. In fact, a spare set of filament leads and three spare filaments accompany each VeB-6. All power supplies, controls, feedthroughs, cables, and positioning supports are included in the basic system.

Ease of maintenance is also built into the gun. The shield essentially eliminates problems of back-deposition onto the gun. Cleaning of the ceramic spacers and of the stainless anode and cathode surfaces — when occasionally necessary — is simple. Disassembly of the entire gun requires only a screwdriver and may be accomplished in a few minutes.

The filament of the VeB-6 is designed to last at least 500 hours at normal operating pressures; filaments randomly sampled at Veeco have operated for as long as 800 hours before failure. When a filament does fail, however, it can be removed and replaced in a few minutes, keeping expensive down-time to a minimum.

Since the gun is specifically designed for quality vacuum deposition, more efficient operation is obtained. Additionally the entire system, all spare parts, and complete installation and service are available from one manufacturer. This results in less overall expense in production and in maintenance.

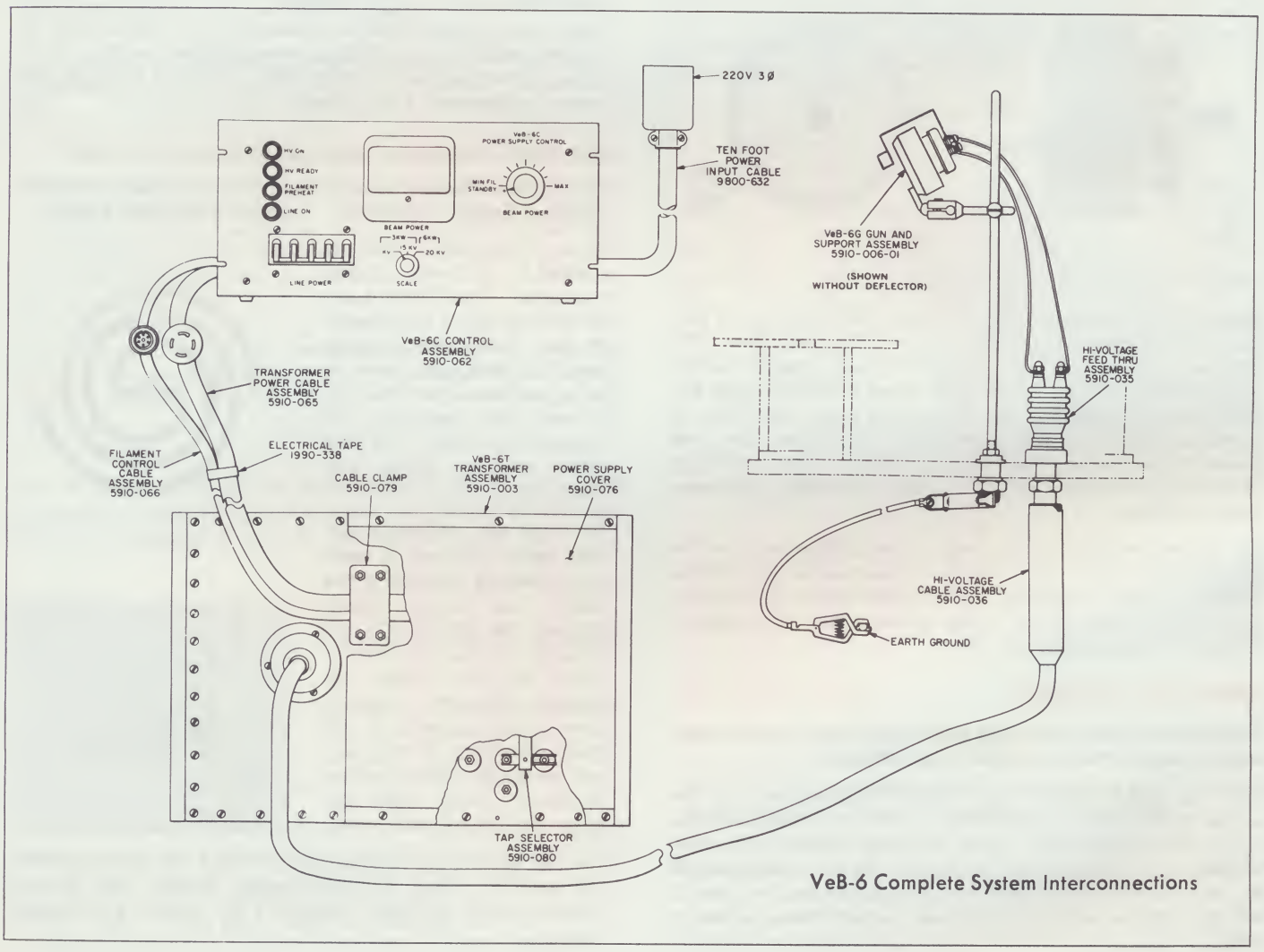
UNEQUALED INSTALLATION AND SERVICE

Installation and service by a trained, graduate Engineer are integral with the purchase of the VeB-6 system package.

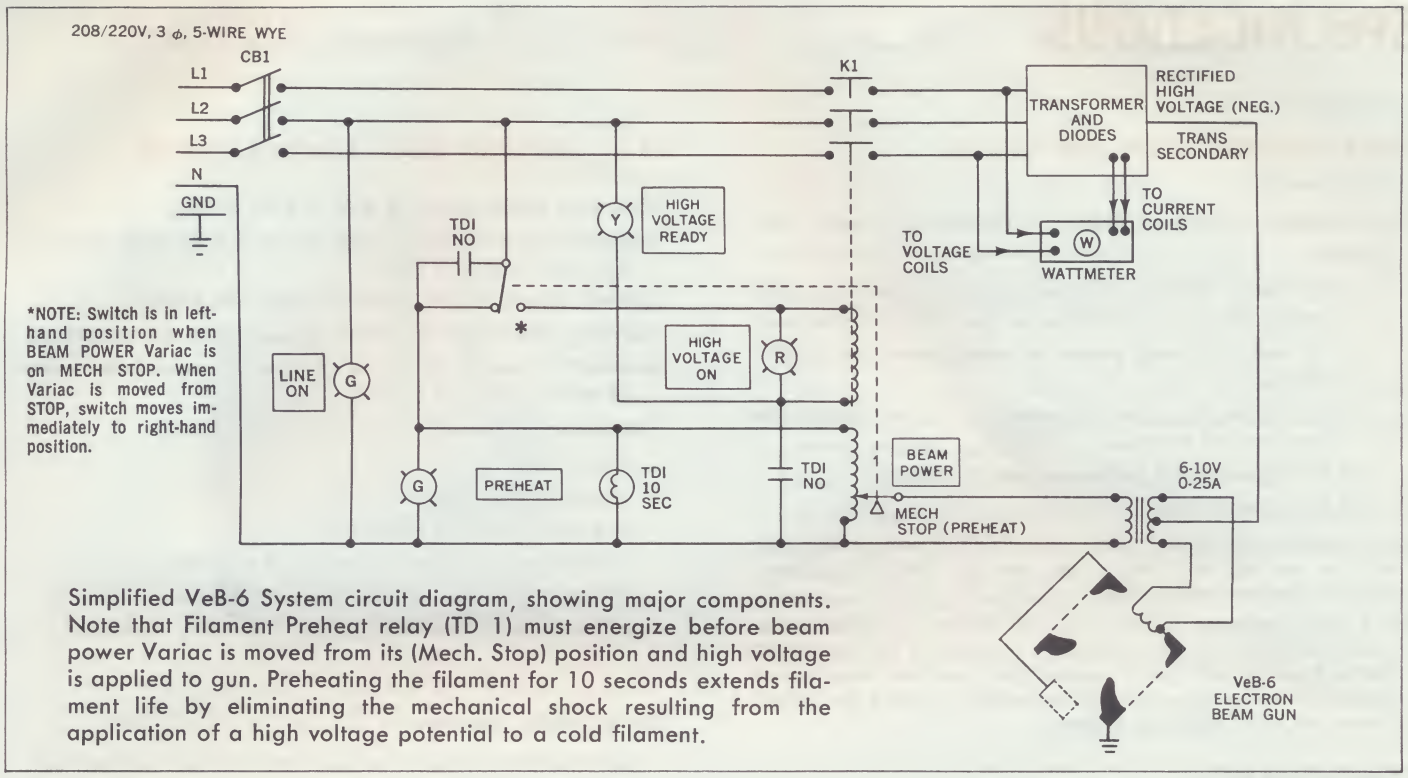
Veeco has always made a point of having field representatives who are technically strong. All of them are graduate engineers, and all of them have undergone intensive training in vacuum technology.

New personnel receive an extensive training program, including extensive technical courses and on-the-job training. Therefore a Veeco representative can talk with you knowledgeably about your requirements and how the VeB-6 can best take care of them.

This same representative will install your VeB-6 when it arrives, and will instruct you and any other personnel you wish in its operation and maintenance. He is also available for special service problems that are outside the scope of the excellent new Operation and Maintenance Manuals that accompany the VeB-6. Thus, he has a responsibility toward you and your VeB-6 that extends throughout the sale and the life of the equipment.

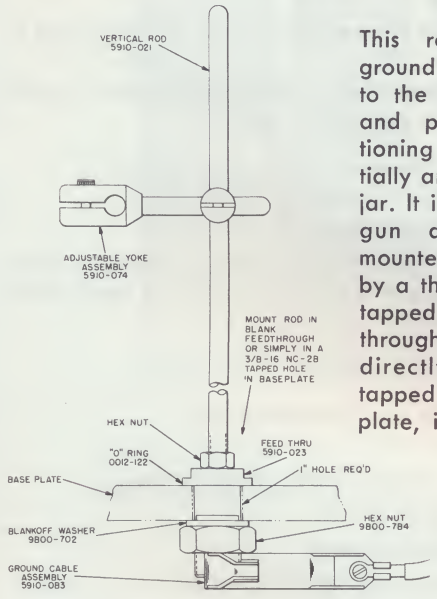


VeB-6 Complete System Interconnections



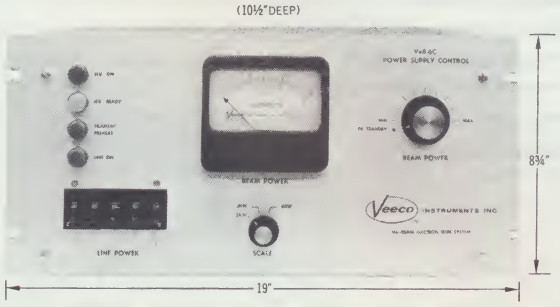
Simplified VeB-6 System circuit diagram, showing major components. Note that Filament Preheat relay (TD 1) must energize before beam power Variac is moved from its (Mech. Stop) position and high voltage is applied to gun. Preheating the filament for 10 seconds extends filament life by eliminating the mechanical shock resulting from the application of a high voltage potential to a cold filament.

Three-dimensional support rod for VeB-6G.

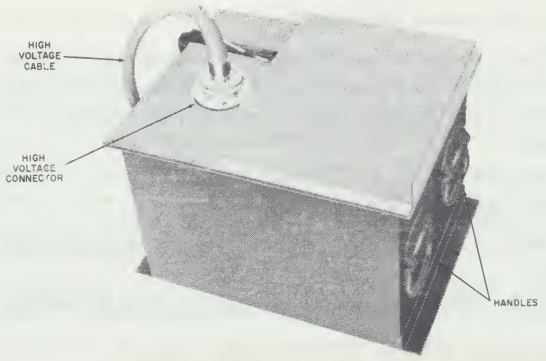


This rod, which is at ground potential, connects to the anode of the gun and provides for positioning of the gun essentially anywhere in the bell jar. It is supplied with the gun and is normally mounted in the baseplate by a threaded connection tapped into a 1" feedthrough. It can be mounted directly in a 3/8-16 tapped hole in the baseplate, if desired.

Dual High-Voltage feedthrough for VeB-6G. This feedthrough carries to the gun both the high voltage and the filament current. It is rated at 24 KV, 30 amperes. As with all Veeco feedthroughs it fits in a standard 1" hole, providing maximum flexibility of baseplate design.



VeB-6C Power Supply Control. Note single knob beam power control. Wattmeter in center of control reads beam power directly in kilowatts.



VeB-6T High-Voltage Transformer. Taps for selecting voltages are beneath cover, as are spark gap and other electrical connections. High voltage cable carries both accelerating potential and filament current, is rated at 30 KV, 25 amps.

SPECIFICATIONS

SYSTEM

VeB-6 ELECTRON BEAM GUN SYSTEM

Components:

VeB-6G, VeB-6D, VeB-6C, VeB-6T

Cables:

a) 10′ cable to carry filament current and voltage, and accelerating high voltage to gun from transformer;

b) 10′ cable to bring power to transformer from control chassis;

c) 10′ cable to bring filament control to transformer from control chassis;

d) 10′ power input cable to control chassis;

e) 10′ ground strap.

Note 1: Because the VeB-6C, VeB-6T and cables are manufactured especially for use with the VeB-6 system, they are not sold separately, except to a present VeB-6G owner.

Note 2: The entire VeB-6 Electron Beam Gun System is manufactured as a complete system. It is not advisable, therefore, to use the VeB-6G Electron Beam Gun with power supplies other than those manufactured expressly for it by Veeco. We will be unable to warrant the VeB-6G if used with other such power supplies.

COMPONENTS

VeB-6G ELECTRON BEAM GUN

Size: 3″ dia x 3″ long

Weight: 2 lbs., 4 ozs.

Focusing: Electrostatic

Gun Type: Pierce type, self-accelerated, space charge limited

Bakeability: To 400°C

Operating pressure range: 10^{-4} torr range to below 10^{-10} torr range

Depth of focus: Constant 2″

Spot Size: ⅛″ dia.

Deflection: Electrostatic

Spot Size: Constant, even while beam power is varied

Beam Density: Uniform across beam diameter

Filament: Self-aligning bifilar, tungsten

Filament life: 500 hrs minimum

Water Cooling: None required

Efficiency: 99.5%

Accessory hardware (furnished):

a) Support rod and feedthrough (fits standard 1″ hole).

b) DFT dual high voltage feedthrough — for filament power and accelerating potential (fits standard 1″ hole).

c) Spare set of two (2) filament leads.

d) Three (3) spare filament assemblies.

e) Shield, to prevent back deposition of evaporant onto gun.

f) Gun Positioner, to accurately point gun at evaporant.

VeB-6D ELECTROSTATIC DEFLECTION PLATE

Deflection: Electrostatic.

Deflection Angle: Approximately 40°.

Attachment: Fastens to gun by two screws.

Material: Stainless steel.

VeB-6C ELECTRON BEAM CONTROL CHASSIS

Maximum Beam Power: 6 KW, 3 KW, 2 KW.

Maximum Beam Current: 300 ma at 6 KW; 200 ma at 3 KW; 185 ma at 2 KW.

Control: Beam power varied by only one knob.

Metering: Beam power read out in watts on wattmeter.

Automatic Control: Beam power can be regulated by use of rate or thickness monitor.

Interlocks:

Circuit breaker opens when:

a) Input current exceeds CB rating.

b) Anode shorts to cathode.

c) High voltage terminal shorts to ground.

d) Electron or ion current overload exists.

e) Total beam current exceeds allowable maximum.

Other Safety Features:

a) Ten-second delay must be observed for filament preheat.

b) Interlock is provided for attachment of customer's vacuum gauge.

c) Filament cannot be energized unless current Variac is zeroed.

d) High voltage cannot be applied until filament current Variac passes a minimum value.

Mounting: Rack or console.

Dimensions: 19″ W x 8¾″ H x 10½″ D.

Weight: Approximately 50 lbs.

Line Power Services: 220V, 3ϕ, 50-60 cps Wye. (If Delta wiring is desired, please specify; a separate transformer will be necessitated.)

VeB-6T HIGH VOLTAGE TRANSFORMER

Voltage: Taps for 11 KV, 15 KV, 20 KV DC (Neg.)

Filament voltage: 6-10 V AC

Filament current: 0-25 amperes

Insulation: Oil-filled for arc-over protection.

Overload protection: Gas filled spark-gap protects against short circuits.

Safety discharge: Internal bleed resistor discharges high voltage circuit 99% in 5 seconds after power is removed from primaries.

Dimensions: 19″ W x 14″ H x 25″ D.

Weight: Approximately 300 lbs.

NOTE: An electron beam gun may produce X-radiation at certain voltages when used with certain target materials. Proper shielding precautions must be used in accordance with the recommendations of your local and state regulatory agencies.

Specifications subject to change without notice.

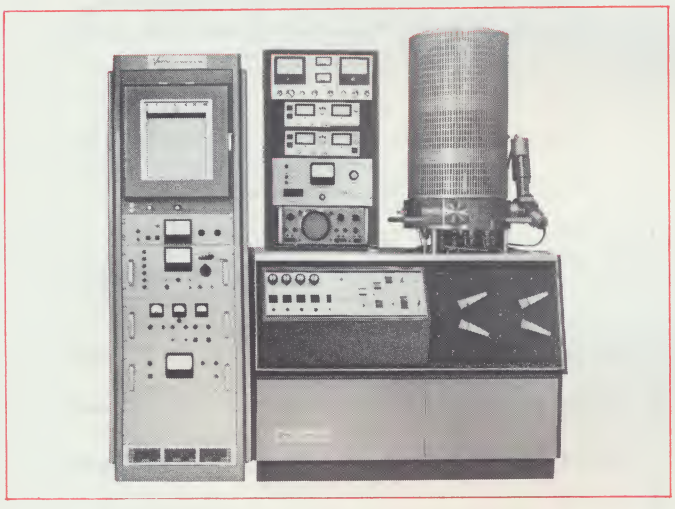
RECOMMENDED EQUIPMENT FOR USE WITH VeB-6

MODEL VE-775 HIGH VAC. EVAP

Ultra-clean evaporator for use with VeB-6 Electron Beam Gun System. For maximum cleanliness, resulting in increased yield, the VE-775 is offered exclusively with a water-cooled baffle *and* a liquid nitrogen cold trap.

Features

- Models — Completely automatic; Semi-automatic; Manual
- Baffling — Two distinct optically-dense baffles, one water-cooled, one LN_2-cooled.
- Speed — Over 500 lit/sec measured *in bell jar.*
- Low Ultimates — Pressures in 10^{-8} torr range measured in bell jar; less than 5×10^{-8} torr at stub. *Ultimates consistently achieved.*
- Modular concept for maximum present and future flexibility.
- Easy to use: non-skilled personnel can operate.



As an example of the use of the above equipment, shown to the left is a complete laboratory for thin-film studies. It consists of VeB-6 Electron Beam Gun mounted in a VE-775 Evaporator, with GA-4R Gas Analyzer and Thickness Monitor. It can also be used for nearly completely-programmed production evaporation, with precise control over each production run.

WARRANTY—VEECO ELECTRON BEAM GUN

1. The warranties hereinafter set forth ARE EXPRESSLY IN LIEU OF ANY OTHER EXPRESS OR IMPLIED WARRANTY. Except as otherwise provided herein Veeco warrants that if used in accordance with the operation and maintenance manual and in a proper vacuum environment, this E-beam gun system will be free from defects in material and workmanship for a period of one year from date of shipment, the obligation of Veeco being limited to either replace, repair or adjust defective parts and materials or to issue credit therefor at its option. The obligation of Veeco shall not extend to defects that do not impair service. No claim will be allowed for equipment damaged by the purchaser or damaged in transit, nor for any defect arising from purchaser's failure to register this equipment under applicable state law, nor for any defect unless Veeco shall have received notice of the defect within thirty days following its discovery by purchaser. Within thirty days of purchaser's receipt of equipment Veeco must receive notice of any defect which purchaser could have discovered by prompt inspection of equipment. In any event, Veeco shall have the option of inspection at purchaser's premises or at its own plant, before allowing or rejecting the claim. This one year warranty extends to component parts which are manufactured by persons other than Veeco. Veeco assumes no liability in any event for consequential damages, damages caused by or exposure to radiation, for anticipated or lost profits, incidental damages or loss of time or other losses incurred by the purchaser or any third party in connection with equipment covered by this warranty or otherwise.

2. All pilot lights, filaments, fuses and other expendable electrical components ARE EXCLUDED FROM THE FOREGOING WARRANTY AND ARE NOT WARRANTED.

HOW TO ORDER

Complete Electron Beam System, as described in this brochure, order VeB-6
Additional Electron Beam Gun(s) VeB-6G

See your Veeco Field Engineer for specific prices and answers to any questions concerning the equipment and/or its application(s).

Order directly from your local Veeco office, or send order direct to Veeco Instruments, Inc., Terminal Drive, Plainview, N. Y. 11803, Attention: Order Department, or call collect (516) 681-8300.

VEECO OFFICES

Qualified vacuum engineers will answer your questions.

Call now and make an appointment.

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Regional Office: Plainview, N. Y., 11803, 20 Dupont Street
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Palo Alto, Calif. 94306, 210 California Avenue, Suite B
Tel. 415 327-5931
Albuquerque, New Mexico 87111, P.O. Box 11604
Tel. 505 247-4854
Denver, Colorado, Tel. 303 238-0158

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Radionics Limited, 4938 Yonge Street, Willowdale, Ontario
Tel. 416 222-3261
Radionics Limited, 376 Churchill Avenue, Ottawa 3, Ontario
Tel. 613 728-5533

JAPAN

Tokyo Electron Laboratories, Inc., TBS Building
Akasaka, Tokyo, Japan, Tel. 584-5611

AUSTRALIA

National Instruments Co. Pty. Ltd., Melbourne Airport
Essendon W.6, Tel. 379-1528

ISRAEL

Elina, Ltd., P.O.B. 960, 52, Nachlat Benyamin Street, Tel-Aviv
Tel. 52068

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